CLAIMS

What is claimed is:

Sub B1

1. A method of controlling a catalytic combustion system comprising an air supply, a flame burner, a fuel injector positioned downstream of the flame burner and a catalyst positioned downstream of the fuel injector, a flow path containing a valve that directs a portion of the airflow to bypass the catalyst, wherein a portion of the fuel combusts within the catalyst and a remainder of the fuel combusts in the region downstream of the catalyst, comprising:

determining the adiabatic combustion temperature at the catalyst inlet;

adjusting the airflow that bypasses the catalyst to maintain the adiabatic combustion temperature at the catalyst inlet within a predetermined range.

2. The method of claim 1, wherein the adiabatic temperature is determined by monitoring a) the airflow through the combustor, b) the fuel flow to the combustor and c) the temperature of the gas mixture entering the combustor.

3. The method of claim 2, wherein the airflow through the combustor is determined by measuring the airflow through the compressor, multiplying by the fraction of air flowing to the combustor, and subtracting the airflow through the bypass.

4. The method of claim 3, wherein the airflow through the compressor is determined by measuring the pressure drop at the compressor inlet bell mouth.

5. The method of claim 3, wherein the airflow through the bypass is determined by a flow measuring device located in the bypass flow path.

6. The method of claim 5, wherein the flow measuring device consists of a restriction to the flow and a sensor to measure pressure drop across the resistance.

7. A method of controlling a catalytic combustion system comprising an air supply, a flame burner, a fuel injector positioned downstream of the flame burner and a

catalyst positioned downstream of the fuel injector, a flow path containing a valve that directs a portion of the airflow to bypass the catalyst, wherein a portion of the fuel combusts within the catalyst and a remainder of the fuel combusts in the region downstream of the catalyst, comprising:

determining the adiabatic combustion temperature at the catalyst inlet;

measuring the exhaust gas temperature;

calculating the exhaust gas temperature at full load;

adjusting the airflow that bypasses the catalyst to maintain the adiabatic combustion temperature at the catalyst inlet based upon a predetermined schedule that relates the i) adiabatic combustion temperature at the catalyst inlet to ii) the difference between the measured exhaust gas temperature and the calculated exhaust gas temperature at full load.

8. The method of claim 7, wherein the adiabatic temperature is determined by monitoring a) the airflow through the combustor, b) the fuel flow to the combustor and c) the temperature of the gas mixture entering the combustor.

9. The method of claim 8, wherein the airflow through the combustor is determined by measuring the airflow through the compressor, multiplying by the fraction of air flowing to the combustor, and subtracting the airflow through the bypass.

10. The method of claim 9, wherein the airflow through the compressor is determined by measuring the pressure drop at the compressor inlet bell mouth.

11. The method of claim 9, wherein the airflow through the bypass is determined by a flow measuring device located in the bypass flow path.

12. The method of claim 11, wherein the flow measuring device consists of a restriction to the flow and a sensor to measure pressure drop across the resistance.

Sub B1

13. The method of claim 7, wherein the exhaust gas temperature is measured by a thermocouple installed in the exhaust stream.

14. A method of controlling a catalytic combustion system comprising an air supply, a flame burner, a fuel injector positioned downstream of the flame burner and a catalyst positioned downstream of the fuel injector, a flow path containing a valve that directs a portion of the airflow to bypass the catalyst, wherein a portion of the fuel combusts within the catalyst and a remainder of the fuel combusts in the region downstream of the catalyst, comprising:

determining the adiabatic combustion temperature at the catalyst inlet;

measuring the load;

calculating full load;

adjusting the airflow that bypasses the catalyst to maintain the adiabatic combustion temperature at the catalyst inlet based upon a predetermined schedule that relates the i) adiabatic combustion temperature at the catalyst inlet to ii) the difference between the measured load and the calculated full load.

15. The method of claim 14, wherein the adiabatic temperature is determined by monitoring a) the airflow through the combustor, b) the fuel flow to the combustor and c) the temperature of the gas mixture entering the combustor.

16. The method of claim 15, wherein the airflow through the combustor is determined by measuring the airflow through the compressor, multiplying by the fraction of air flowing to the combustor and subtracting the airflow through the bypass.

17. The method of claim 16, wherein the airflow through the compressor is determined by measuring the pressure drop at the compressor inlet bell mouth.

Sub A1

18. The method of claim 18, wherein the airflow through the bypass is determined by a flow measuring device located in the bypass flow path.

Sub B1

19. The method of claim ~~18~~, wherein the flow measuring device consists of a restriction to the flow and a sensor to measure pressure drop across the resistance.

Sub B2
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20. The method of claim 14, ~~further~~ comprising; a power turbine downstream of the catalyst and a generator connected to the power turbine wherein the measured load is the output of the generator.

Sub B3

21. The method of claim 20, wherein the difference between the load and the calculated full load is determined from the turbine compressor discharge pressure, and exhaust gas temperature.

22. The method of claim 14, wherein the catalyst is controlled via a schedule versus fuel air ratio (at the catalyst inlet) or Tad (adiabatic combustion temperature) or EGT-delta (difference between calculated exhaust gas temperature at full load and measured exhaust gas temperature) in combination with a bypass and bleed.

23. A method of controlling a catalytic combustion process consisting of a combustion zone through which air is flowed wherein the process includes, a fuel injection means to provide fuel to a catalyst and one or more catalyst sections wherein:

a portion of the fuel is combusted within the catalyst and the remaining fuel exits the outlet face of the catalyst and combusts in a homogeneous combustion reaction in the space downstream of said catalyst outlet face,

a bypass system operation is based on engine output power to maximize the low emissions operating range of said catalyst, and

the bypass valve closed loop control is based on a flow measuring device.

24. The method of claim 23, in which

the bypass system operation is based on fundamental engine performance measurements such as exhaust gas temperature, ambient temperature, compressor discharge pressure, compressor discharge temperature.

Sub B1

25. The method of claim 23, in which

the bypass valve closed loop control is based on the valve's feedback position

Sub A3

26. A method of controlling a catalytic combustion process consisting of a combustion zone through which air is flowed wherein the process includes, a fuel injection means to provide fuel to a catalyst and one or more catalyst sections wherein:

a portion of the fuel is combusted within the catalyst and the remaining fuel exits the outlet face of the catalyst and combusts in a homogeneous combustion reaction in the space downstream of said catalyst outlet face,

the bypass system operation is based on fundamental engine performance measurements such as exhaust gas temperature, ambient temperature, compressor discharge pressure, compressor discharge temperature

the bypass valve closed loop control is based on the valve's feedback position.

27. A method of controlling a catalytic combustion process consisting of a combustion zone through which air is flowed wherein the process includes, a fuel injection means to provide fuel to a catalyst and one or more catalyst sections wherein:

a portion of the fuel is combusted within the catalyst and the remaining fuel exits the outlet face of the catalyst and combusts in a homogeneous combustion reaction in the space downstream of said catalyst outlet face,

a bleed system operation is based on exhaust gas temperature to maximize the low emissions operating range of said catalyst

the bleed valve closed loop control is based on exhaust gas temperature.

Sub B1

28. A method of controlling a catalytic combustion process consisting of a combustion zone through which air is flowed wherein the process includes, a fuel injection means to provide fuel to a catalyst and one or more catalyst sections wherein:

a portion of the fuel is combusted within the catalyst and the remaining fuel exits the outlet face of the catalyst and combusts in a homogeneous combustion reaction in the space downstream of said catalyst outlet face,

a bypass system operation is based on engine output power to maximize the low emissions operating range of said catalyst,

a bleed system operation is based on exhaust gas temperature to further increase the low emissions operating range of said catalyst,

the bypass valve closed loop control is based on a flow measuring device, and

the bleed valve closed loop control is based on exhaust gas temperature.

29. A method of controlling a catalytic combustion system comprising a combustor having an air supply, a flame burner, a fuel injector positioned downstream of the flame burner and a catalyst positioned downstream of the fuel injector, a flow path containing a valve that directs a portion of the airflow to bypass the catalyst, wherein a portion of the fuel combusts within the catalyst and a remainder of the fuel combusts in the region downstream of the catalyst, comprising:

measuring at least one thermodynamic combustion system parameter;

selecting a first predetermined schedule that relates the at least one thermodynamic combustion system parameter to a predetermined airflow that bypasses the catalyst;

controlling the airflow that bypasses the catalyst by selecting the predetermined airflow that bypasses the catalyst from the first predetermined schedule based on the at least one measured thermodynamic combustion system parameter.

Sub A4

30. The method of claim 30 or 34 wherein in the at least one thermodynamic combustion system parameter is selected from the group consisting of the exhaust gas temperature, the difference between the exhaust gas temperature and a calculated exhaust gas temperature at full load, the turbine inlet temperature; the combustor outlet temperature, the combustor inlet temperature, turbine load, the catalyst inlet temperature, catalyst temperature, the catalyst outlet temperature, the adiabatic combustion

a4

temperature, the preburner outlet temperature, the preburner inlet temperature, the preburner inlet pressure, the preburner outlet pressure, the catalyst inlet pressure, the catalyst outlet pressure, the combustor inlet pressure, the combustor outlet pressure, fuel flow to a primary zone preburner, fuel flow to a secondary zone preburner, fuel flow to the combustor, fuel flow to the catalyst, airflow to a primary zone preburner, airflow to a secondary zone preburner, and airflow to the combustor.

sub B1

31. The method of claim 30 further including the steps of:

providing feedback of the at least one thermodynamic combustion system parameter; and

adjusting the airflow that bypasses the catalyst based on the feedback.

sub a5

32. The method of claim 32 wherein the feedback is closed loop.

33. The method of claim 30 further including the steps of:

providing a flow path containing a valve that bleeds combustor inlet air flow;

measuring at least one thermodynamic combustion system parameter;

selecting a second predetermined schedule that relates the at least one thermodynamic combustion system parameter to a predetermined airflow that bleeds combustor inlet air flow; and

controlling the airflow that bleeds combustor inlet air flow by selecting the predetermined airflow that bleeds combustor inlet air flow from the second predetermined schedule based on the at least one measured thermodynamic combustion system parameter.

34. The method of claim 34 further including the steps of:

providing feedback of the at least one thermodynamic combustion system parameter; and

adjusting the airflow that bleeds combustor inlet air flow based on the feedback.

Sub B'

~~35. The method of claim 34 wherein the feedback is closed loop.~~

Sub a6

36. The method of claim 30 or 34 wherein the step of controlling the airflow that bypasses the catalyst includes the step of preselecting a thermodynamic combustion system parameter setpoint.

37. The method of claim 37 wherein the combustion system parameter setpoint is selected to reduce combustor emissions.

38. The method of claim 37 wherein the step of controlling the airflow that bleeds combustor inlet air flow includes adjusting the airflow that bleeds combustor inlet air flow to maintain the setpoint.

39. The method of claim 34 wherein the step of controlling the airflow that bleeds combustor inlet air flow includes the step of preselecting a second thermodynamic combustion system parameter setpoint.

40. The method of claim 40 wherein the step of controlling the airflow that bleeds combustor inlet air flow includes the step of adjusting the airflow that bleeds combustor inlet air flow to maintain the second setpoint.

41. The method of claim 40 wherein the second thermodynamic combustion system parameter setpoint is selected to reduce combustor emissions.

Sub B'

42. A method of controlling a catalytic combustion system comprising a combustor having an air supply, a flame burner, a fuel injector positioned downstream of the flame burner and a catalyst positioned downstream of the fuel injector, a flow path containing a valve that bleeds combustor inlet air flow, wherein a portion of the fuel combusts within the catalyst and a remainder of the fuel combusts in the region downstream of the catalyst, comprising:

measuring at least one thermodynamic combustion system parameter;

selecting a first predetermined schedule that relates the at least one thermodynamic combustion system parameter to a predetermined airflow that bleeds combustor inlet air flow;

controlling the airflow that bleeds combustor inlet air flow by selecting the predetermined airflow that bleeds combustor inlet air flow from the first predetermined schedule based on the at least one measured thermodynamic combustion system parameter.

SHB a7

43. The method of claim 43 wherein in the at least one thermodynamic combustion system parameter is selected from the group consisting of the exhaust gas temperature, the difference between the exhaust gas temperature and a calculated exhaust gas temperature at full load, the turbine inlet temperature; the combustor outlet temperature, the combustor inlet temperature, turbine load, the catalyst inlet temperature, catalyst temperature, the catalyst outlet temperature, the adiabatic combustion temperature, the preburner outlet temperature, the preburner inlet temperature, the preburner inlet pressure, the preburner outlet pressure, the catalyst inlet pressure, the catalyst outlet pressure, the combustor inlet pressure, the combustor outlet pressure, fuel flow to a primary zone preburner, fuel flow to a secondary zone preburner, fuel flow to the combustor, fuel flow to the catalyst, airflow to a primary zone preburner, airflow to a secondary zone preburner, and airflow to the combustor.

44. The method of claim 43 further including the steps of:

providing feedback of the at least one thermodynamic combustion system parameter; and

adjusting the airflow that bleeds combustor inlet air flow.

45. The method of claim 45 wherein the feedback is closed loop.

add B'